NATIONAL ENERGY TECHNOLOGY LABORATORY

Presentation to

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DOE's CCS Program

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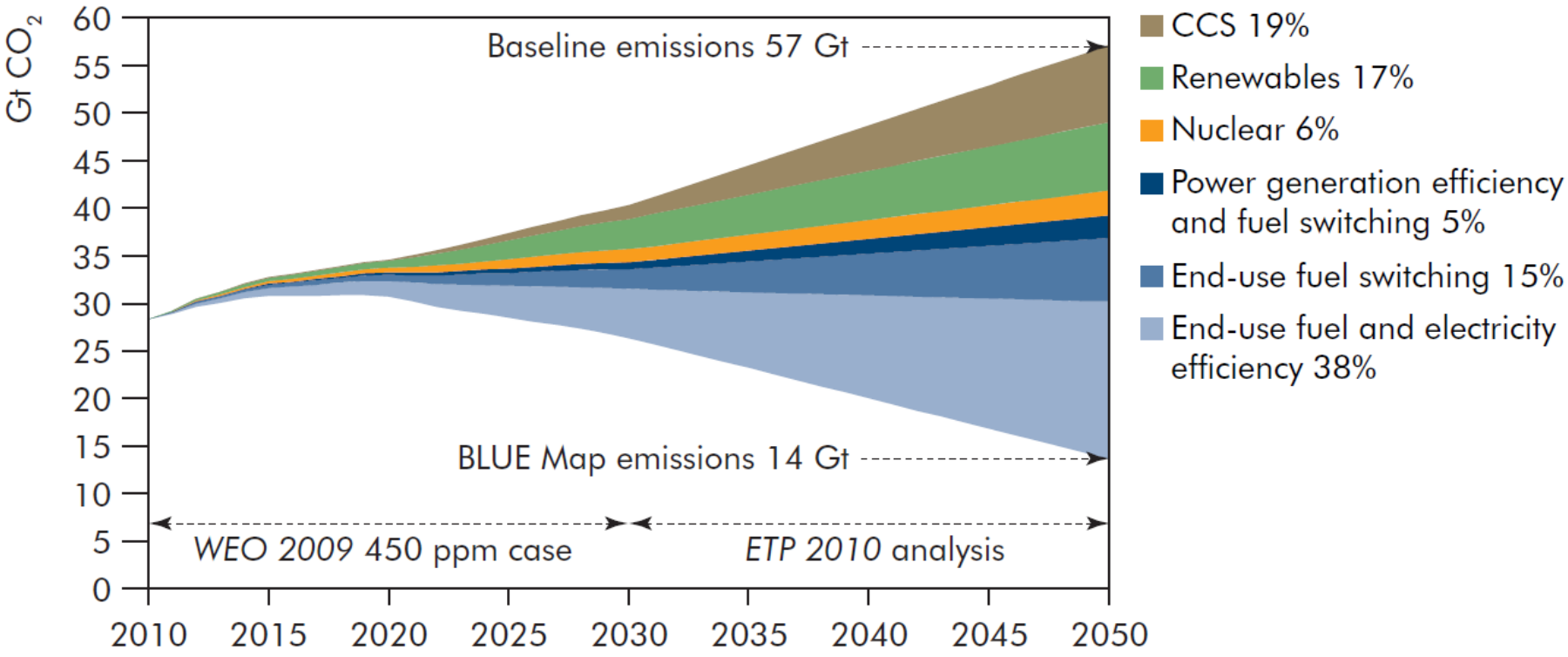
U.S. DEPARTMENT OF ENERGY

Carbon Capture and Storage (CCS) Technologies are Required to Meet CO_2 Abatement Goals

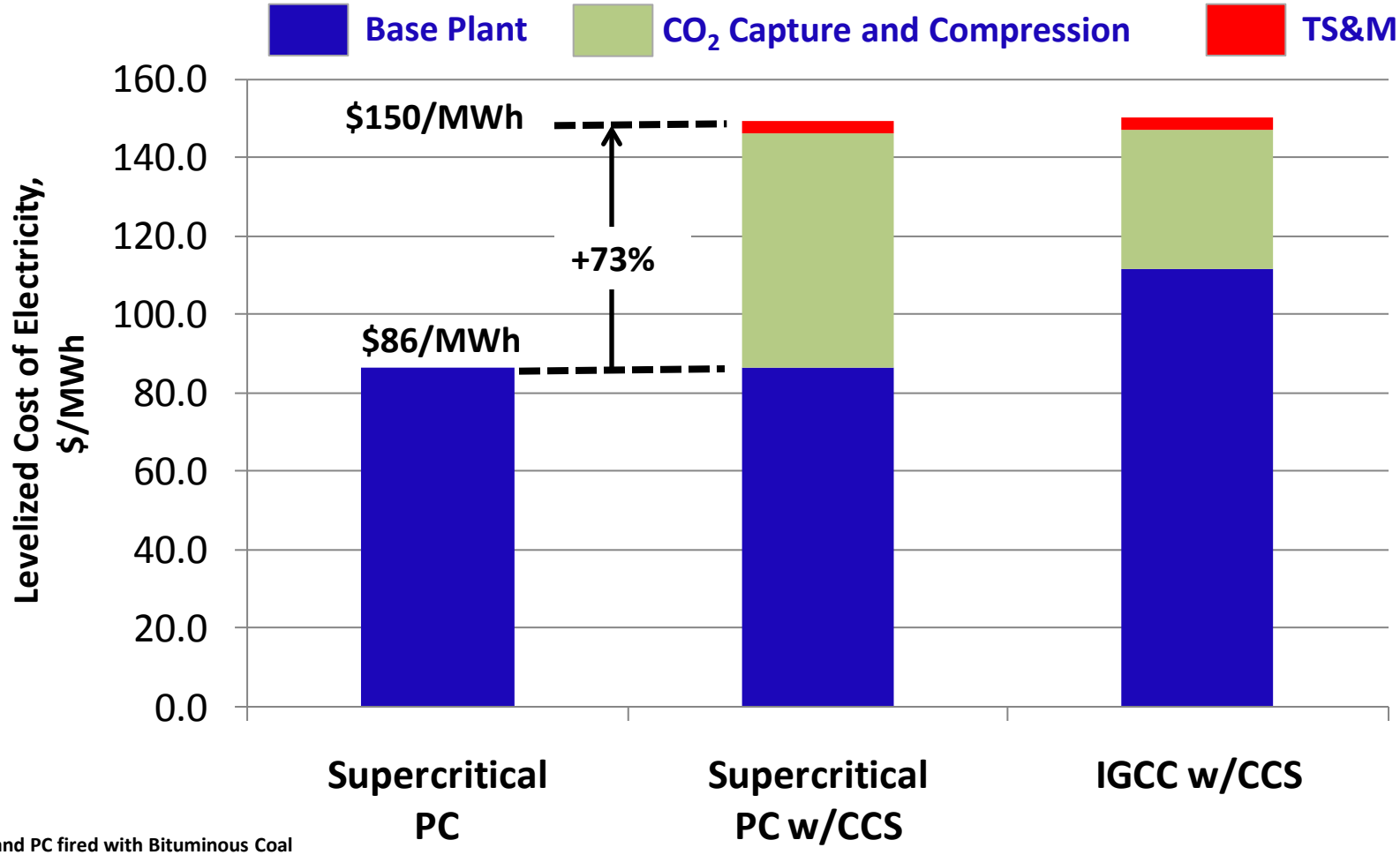


CCS will be required for coal-fired plants initially, and eventually for natural gas plants

Source: International Energy Agency, "Energy Technology Perspectives 2010," Executive Summary, page 3.

Today's CCS Technology is Expensive

Adds over 70% to Electricity Cost (new plant basis)

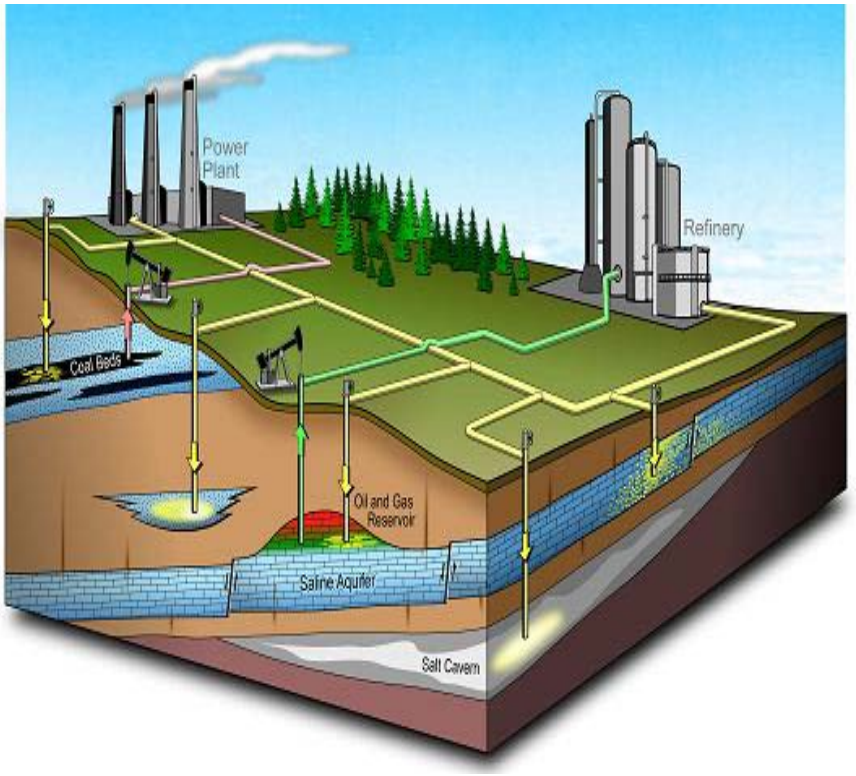


Notes
IGCC and PC fired with Bituminous Coal
CF for IGCC = 80%, PC = 85%
30-Year, Current -Dollar Levelized Cost of Electricity

DOE CCS Program Goals

Deliver CCS technologies & best practices that can provide:

- **90% CO_2 capture at source**
- **99% storage permanence**
- **<10% increase in cost of electricity (COE)**
  - Pre-combustion capture (IGCC)
- **< 30% increase in COE**
  - Post-combustion capture
  - Oxy-combustion



2nd Generation Capture Technologies

- **IGCC (pre-combustion capture)**
  - 90% capture efficiency
  - 3.5 percentage points higher in efficiency than today's non-capture plants
  - Feedstock/product flexibility (coal, biomass, or opportunity fuels to produce power, liquid fuels, chemicals)
- **Post-Combustion Capture**
  - COE penalty for CCS reduced from +80% to +30%
  - 90% capture efficiency
  - Parasitic energy reduced (from 30% to ~15%)
  - Applicable to new plants, retrofits, natural gas, & industrial power
- **Oxy-Combustion**
  - Increase in COE for CCS cut from +80% to +30%
  - +99% capture potential
  - Parasitic energy reduced (from 30% to ~15%)
  - Applicable to new and existing power plants
  - Co-sequestration opportunities

Example Technologies

ITM Oxygen
Warm gas cleanup
Hydrogen turbine
Solid coal feed pump
Shock wave CO_2 compressor

Advanced Solvents (Ionic liquids, phase change solvents, etc.)
CO_2 membranes
Solid sorbents
USC boiler materials
Shock wave CO_2 compressor

Advanced Oxyfuel Boilers
ITM oxygen
CO_2 purification
USC boiler materials
Shock wave CO_2 compressor
Chemical looping

CCS Technology Deployment Roadmap

1st GEN: CCPI-3 & Industrial CCS

2010 — 2017

Lower Cost/Energy Component Demonstrations
- Separation
- Compression
- Power Efficiency
- Capacity Recovery

Ten Commercial-Scale Demonstrations
- IGCC (3)
- Post-combustion (3)
- Oxy-combustion (1)
- Industrial CCS (3)

Post 2017

Commercial Deployment

2nd GEN: Advanced CCPI-4 CCS Demonstrations

2016 — 2020

Next Generation Demonstrations
- Oxy-combustion
- IGCC
- USC

Next Generation Component Demonstrations
- Coal feed pump
- Warm gas cleanup
- H_2/Syngas turbine
- CO_2 Compression
- Oxygen Separation
- Advanced post-combustion capture

Game Changing Demonstrations
- Post-combustion
  - ✓ Oxy-combustion
  - ✓ PC retrofit
- IGCC

Game Changing Component Demonstrations
- CO_2 Membranes
- Solvents
- Sorbents
- O_2 Membranes

Post 2020

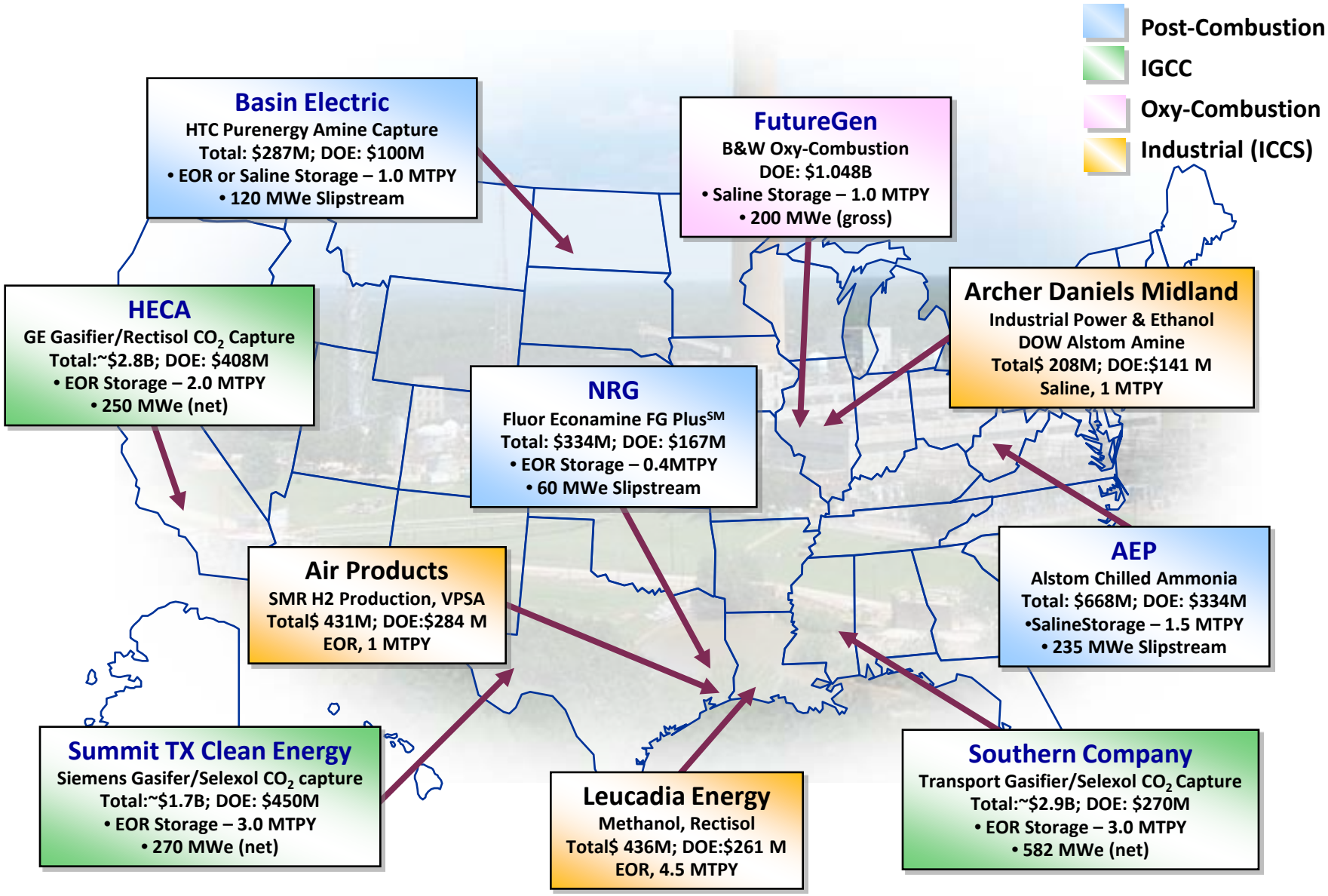
Commercial Deployment

Regional Carbon Sequestration Partnerships

Pre-Injection	Injection	Post-Injection	Additional MVA

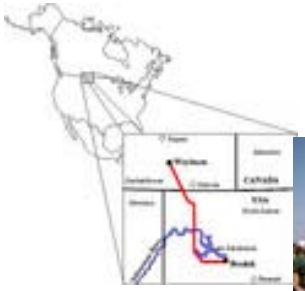
BPM 1 — BPM2 — BPM Final

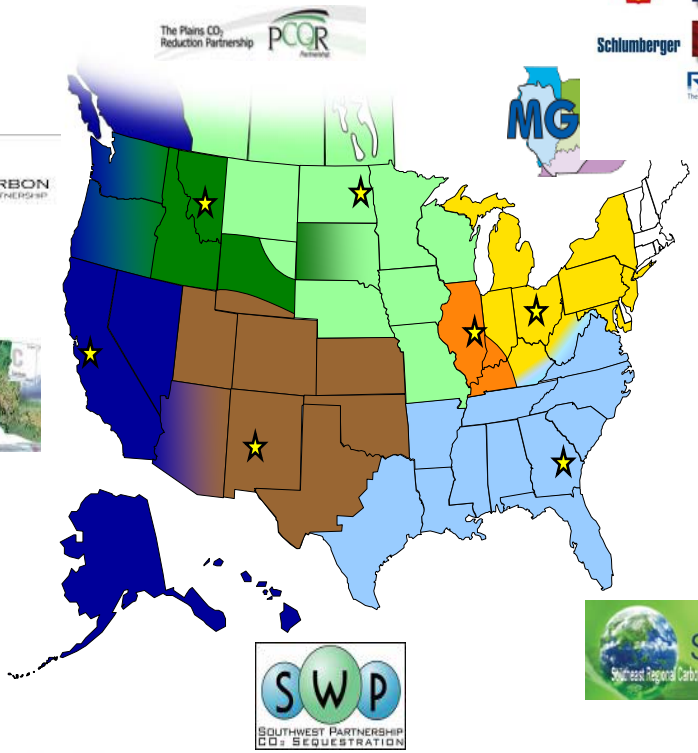
Major CCS Demonstration Projects



Advancing CCS

Sharing of Lessons Learned





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